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MEMORANDUM

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FINAL REPORT LEAK DETECTOR DEVELOPMENT (CONTRACT NAS8-11898)

By Methods and Research Section
Quality Assurance and Reliability Laboratory

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NASA

George C. Marshall Space Flight Center
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FINAL REPORT

LEAK DETECTOR DEVELOPMENT

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ABSTRACT

The purpose of this report is to describe the work done by Aerovac, Inc., of Green Island, New York, under contract NAS8-11898. This contract called for the development of a motor driven sampling valve, the improvement of existing circuitry, and the complete design and fabrication of a halogen leak detector based on a gradient sensing design originated by Ohio University under separate contract. Prior to completion of the work, further developments in sensor design rendered this design obsolete. Therefore the contract was cancelled.

METHODS AND RESEARCH SECTION
MECHANICAL TEST BRANCH
ANALYTICAL OPERATIONS DIVISION

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SUMMARY

The purpose of this report is to describe the work done by Aerovac, Inc. Green Island, New York,. under contract NAS8-11898. This contract called for the exploitation of a leak detector design, based on gradient detection, developed by Ohio University. This was to be accomplished by designing a motor driven sampling valve, refining the circuitry designed by Ohio University, doing a complete packaging design, and fabricating prototypes for field testing.

Aerovac had completed the valve design, circuit refinements, and the initial phase of the package design when further development in gradient sensor design rendered the existing design completely obsolete. Since the final product would be obsolete, the contract was terminated in the interest of the Government.

A. INTRODUCTION

Ohio University, under contract NAS8-11199, investigated leak detection problems in considerable depth. One area of particular interest was the use of tracer gas techniques especially those utilizing halogens such as Freon. Most halogen detectors sense the absolute level of the ingested samples, and therefore in a contaminated atmosphere, such as often occurs in test cells and checkout areas, small leaks go undetected due to the masking effect of the contamination.

This problem was studied in detail, and the concept of a gradient detector evolved. This is based on the concept that although a small change in a large quantity is hard to find, the difference between two large quantities can be detected and measured with much more precision and resolution. Hardware was developed utilizing this concept and the theory proved sound.

B. DISCUSSION

The detection system devised by Ohio University consisted of two probe tubes fed into a single sensor. Pneumatic switching caused the sample to be drawn alternately from the two sample probes. Variation in halogen concentration in the two probe locations caused a variation in sensor output. Electronic switching synchronized with the pneumatic switching permitted the alternating signal to be treated as two signals of opposite polarity which could be bucked together, thus cancelling the equal portion, leaving the difference to be amplified and used.

Thus the gradient caused by a small leak emanating into a contaminated environment could be detected, and the leak located even though the absolute signal level was so large that the variations could not be otherwise detected.

The prototype, built and demonstrated by Ohio University, proved the concept; however, considerable engineering design and development remained before a working version suitable for field use could be produced. The two principal weaknesses of the detection system were the pneumatic switching and the reliability of the electronic circuitry. As a result of this, a decision was made by NASA to initiate a separate contract with a commercial firm to complete the engineering development, and produce several units for field testing and evaluation.

A contract, NAS8-11898, was signed with Aerovac, Inc., in 1965 to complete this project. The principal requirements of the contract were:

(1) Design an electrically operated pneumatic switch (valve) to alternate sample ports

(2) Refine the existing circuitry to achieve greater stability and reliability

(3) Design a convenient, usable package

(4) Build six prototypes for field testing.

The Ohio built prototype with circuit diagrams was provided for Aerovacs use.

1. Valve Design. The first problem to be solved was the design of the pneumatic switch (valve). This valve had several unusual requirements. It had to be "make before break" with minimum perturbation in the flow, have very low flow resistance, require very little power to operate, and have a long life expectancy. It was required to operate six times per second for a life expectancy in excess of 1000 hours.

Aerovac produced an excellent design that met or exceeded all requirements. They made an important improvement over the original concept by adding a second vacuum circuit that maintained the flow through the channel not feeding the sensor, thus assuring a fresh sample the next cycle. This feature significantly reduces the overall response time of the system.

The valve design is shown in figures 1 and 2. Figure 1 shows the valve at the "make before break" change over point, and figure 2 shows the valve rotated 90 degrees sampling through one port and flowing to waste through the other. The two ports to the GE Sensor are joined at a tee connection external to the valve. A single line continues to the sensor from this point.

2. Electronics Modification. The second problem to be solved was the modification of the electronic package designed and buil' by Ohio University. The number of improvements required to achieve satisfactory reliability was much greater than had been anticipated. The problem was further complicated by frequent failures of the system due to poorly chosen components and bad fabrication techniques used by Ohio University. These failures cost a lot of time troubleshooting while the design changes were being built into this original prototype for test and evaluation purposes.

3. Package Design. When the circuitry was finally brought up to acceptable levels, the package design was undertaken. The preliminary design was completed and sent to NASA for review.

Meanwhile, work on halogen sensor development was continuing at Ohio University. Their development work on the sensor culminated in a modified commercial sensor, split mechanically and electrically along the longitudinal axis, permitting two samples to be pulled continuously and simultaneously through the sensor. Electronic switching alternately sampled the outputs of the two halves and the signals are compared as explained previously.

This development elimirates the pneumatic switching, the synchronizing circuit, and permits much higher switching frequencies. The higher switching rate improves response time and permits considerable circuit simplification with resultant stabil'y, and reliability.

This development, as demonstrated with bench and breadboard hardware, was shown to be very superior and rendered the older system so obsolete that completion of the contract was valueless. Therefore, the contract was terminated in the interest of the Government.

C. CONCLUSIONS AND RECOMMENDATIONS

The contract with Aerovac produced a pneumatic switch (valve) that is unique and an extremely good design. This valve should prove to be of value on other projects requiring alternate sampling of gases. It is currently planned to proceed with development of the split sensor inhouse, possibly utilizing some of the electronics design performed by Aerovac.

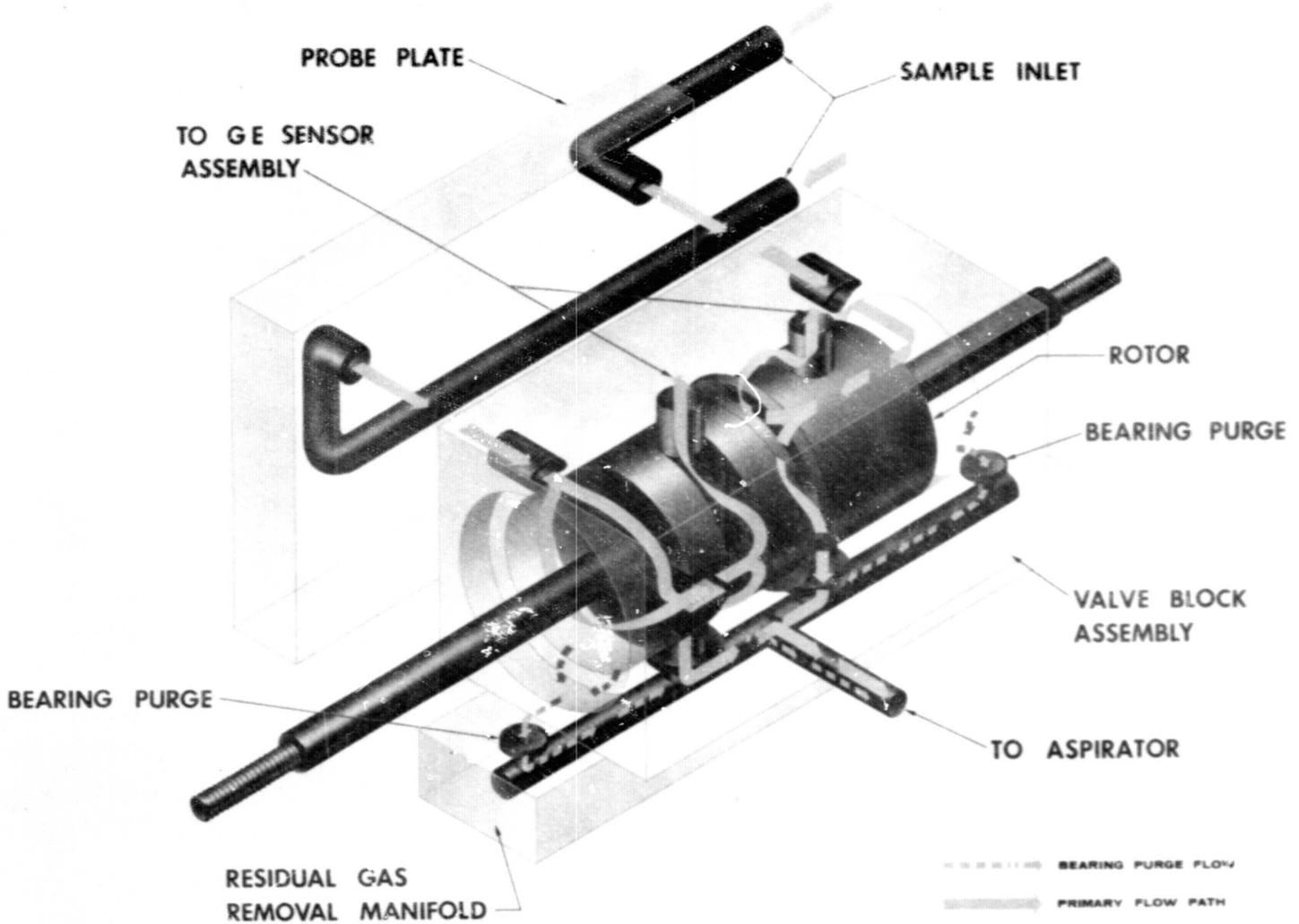

Figure 1. Pneumatic Switch (Valve), Changing Flow Samples

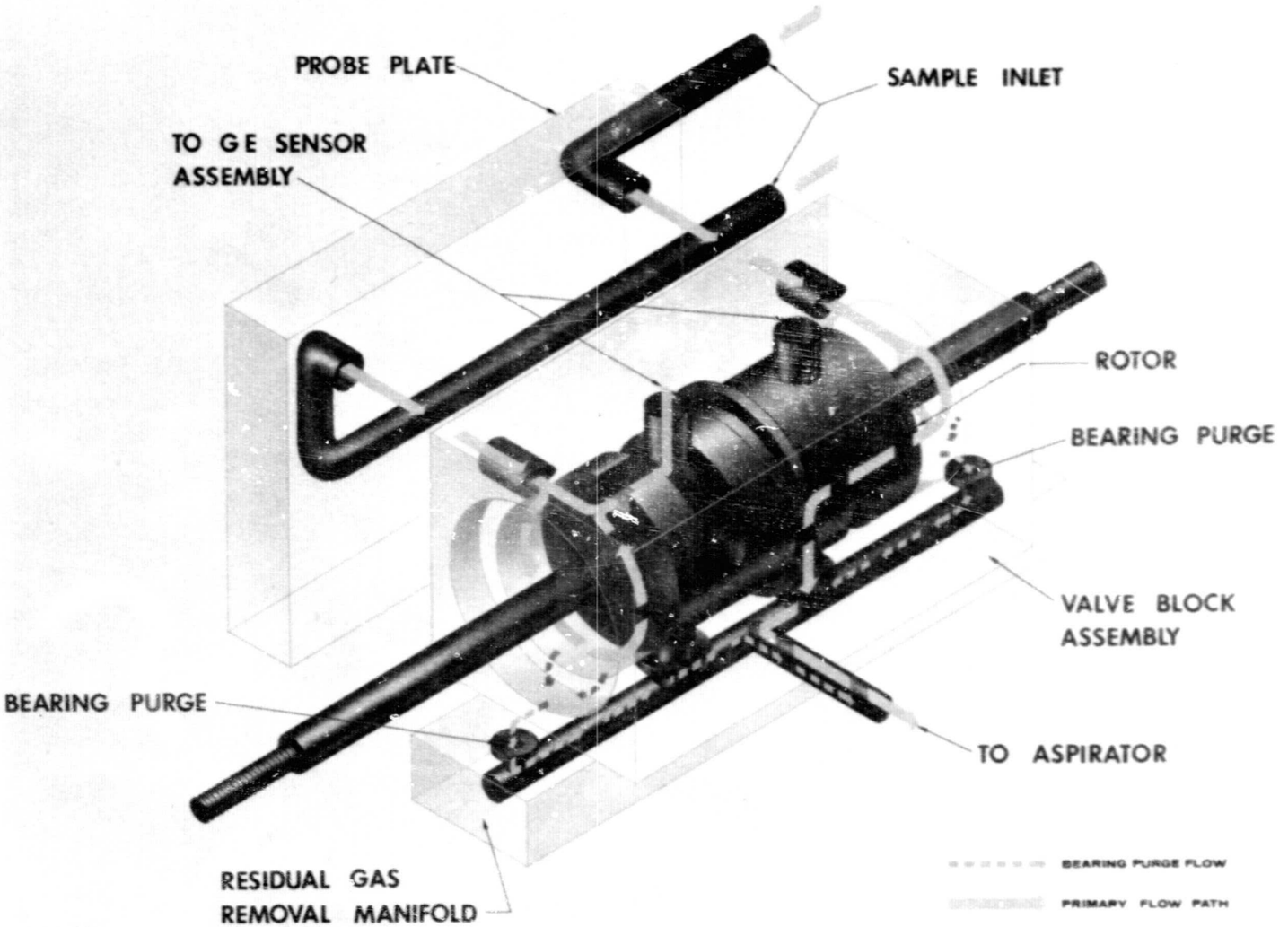

Figure 2. Pneumatic Switch (Valve), Sample Flow

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APPROVAL

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The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

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